

# **EXPLOSAFE: New, Efficient, and Low Cost Developments for Safe Transportation and Storage of Explosive Substances and Articles**

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## **1. Introduction.**

The Company.

Dangerous Goods Management (DGM), is specialized in packing, storage, forwarding and consultancy, all according to global regulations (IATA/ICAO-ADR-IMO), of hazardous materials.

DGM was registered in 1988 and holds comprehensive licences to handle, pack, repack, store and arrange transportation of any hazard class of dangerous goods, for air transport, via ocean or by road.

For years, one of DGM's focus points has been the storage and transport of explosives, and the company handles commercial and military shipments as routine.

DGM's head office is in Badhoevedorp, the Netherlands, near Amsterdam Airport. Branch offices are operational in the USA (Houston, Texas), the United Kingdom (London, Aberdeen), Norway (Stavanger, Oslo), Denmark (Copenhagen), Russia (Moscow), Australia (Sydney) and in Singapore.

## **2. Storage and transportation of high explosives.**

Storage and transportation of high explosives gives head-aches to many logistics managers, especially when it comes to forwarding of smaller quantities, such as samples.

Air transport is limited to 1.4 explosives on cargo aircraft and as 1.4S classified explosives on passenger aircraft. Most samples cannot be transported by air.

Ocean transport is feasible, but due to stowage and segregation regulations in the IMDG code, as well as Port restrictions, this is an expensive solution.

DGM has found amazing solutions to such problems and now offers fully tested Explosafe containers to the industry.

There are two types of receptacles, the Explosafe 7.5 and the Explosafe 500.

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### **3. EXPLOSAFE 7.5 - Technical details and tests results**

The DGM Explosafe 7.5 (containment vessel) is made out of aluminum alloys and steel and is mounted with a pressure relief device.

Technical details:

Diameter	: 4 "
Length	: 7.8 "
Diameter of opening	: 2.8 "
Weight	: 4.8 lbs
Volume	: 30.5 cubic inch
Test pressure	: 710.5 pounds p/sq.inch
Dims transportation box	: 11 " x 11 " x 15 "
Weight incl. transportation box	: 28 lbs

The Explosafe 7.5 is suitable for storage and transportation of up to 7.5 grams (0.26 oz) of TNT equivalent, of all types of explosive substances or articles, with exception of articles with shaped charges.

Explosive substances are packed in a tube.

Articles (unpacked) can be fitted with elastic rings or tape to steel bars, which are mounted in the lid of the Explosafe.

This ensures that the explosives are positioned in the centre of the containment vessel.

There must be a space of at least 0.6 inch between the explosives and the inner walls of the Explosafe.

#### **Tests performed on the Explosafe 7.5.**

The Explosafe 7.5 was subjected to the United Nations Series 6(a) and 6© UN Tests and Criteria Manual, second edition, (Document ST/SG/ AC.10/11/Rev.1), which were performed by the Netherlands'(\*) TNO laboratory for Scientific Research, Defence and Explosives Research Department.

(\*) TNO is the official institute for the classification of explosives in the Netherlands.

#### **Tests series 6(a) - Single detonation test**

For this single detonation test, the Explosafe 7.5 was loaded with 5x # 8 electrical detonators, containing a total of 7.5 grams (0.26 oz) of lead azide and PETN.

The detonators were placed in the centre of the vessel, secured to the bars by use of elastic bands. The wires of one detonator were put through the opening of the pressure relief device.

Initiation was effected electrically.

After detonation, there were no visible effects on the outside of the containment vessel and subsequently, there was no endangerment on the surroundings or to the environment, and the vessel could easily be opened by hand.

Examination of the contents showed that all five detonators had exploded, damaging the inner surface of the vessel.

The outer surface of the Explosafe 7.5 did not show any traces of damage at all.

This single package test showed that this containment vessel completely absorbs blast and fragmentation effects of 7.5 grams (0.26 oz) net quantity of explosive substances or articles, containing explosive substances.

### **Tests series 6(c) - External fire (bonfire) test.**

For this test, the Explosafe 7.5 was packed in a especially designed UN approved 4A2 stainless steel box. The inside of the box was lined with 3" thick hard foam isolation material.

The packaging (gross weight 28 lbs) was tested by the Netherlands Packaging Testing Institute TNO and passed the UN Packing Group II performance 4 ft drop test and the 10 ft stack test successfully.

- The lid of the box was sealed by means of a steel lock.
- The Explosafe 7.5 was again loaded with 5x # 8 electrical detonators, which were centred in the vessel, and secured to the steel bars with plastic tape.
- The stainless steel (4A2) box, containing the Explosafe 7.5 was placed on a grid.
- Air-dried pieces of wood were, according to the UN Tests and Criteria Manual procedures, piled under and around the packaging.
- Aluminum witness screens were placed in each of three quadrants, at a distance of 13 ft from the edge of the stack.
- The stack was drenched with 13.2 gallons of fuel (gasoline) and the pile was electrically ignited.
- The fire, with an estimated temperature of 2192°F, lasted for a period of 30 minutes.

At the end of the bonfire test, the red hot box was partly deformed. It took four (4) hours for the packaging to sufficiently cool off, to be handled.

After opening of the stainless steel 4A2 box, containing the Explosafe 7.5, the following observations were made:

- The isolation material was burned and the detonators had initiated.

The Explosafe 7.5 was deformed into the shape of an egg.

- After opening of the vessel, metal parts of the detonators and wires were found in the debris.
- There was no visible effect of blast or fragmentation outside the stainless steel packaging.

#### **4. Technical details and tests performed on the EXPLOSAFE 500**

The DGM Explosafe 500 is a containment vessel, made of various steel alloys and is provided with a pressure relief device.

Between the outer and inner walls, a labyrinth of metal and ceramic materials is placed, to absorb the shock-wave of a detonation.

Technical details:

Diameter	: 16 "
Length	: 25 "
Diameter of opening for loading	: 6.5 "
Weight	: 152 lbs
Volume	: 2 gallons
Dimensions transportation box	: 24 " x 24 " x 32 "
Weight incl. transportation box	: 330 lbs

The Explosafe 500 is suitable for storage and transportation of 500 grams (17.6 oz) TNT equivalent of all type of explosive substances or articles, with exception of articles with shaped charges.

Loading requirements.

The explosives must be centred in the Explosafe. A rubber insert assures that small devices, such as hand grenades, are automatically centred. To load larger devices, such as bombs or mortar shells, special rubber rings are supplied to enable to centre these explosives inside the container.

After loading, the Explosafe is firmly closed with a strong screw-type lid, which can be secured by hand force.

A special dolly facilitates relocation of the explosive devices to a safer place by one person, and also staircases can be negotiated with ease.

#### **Tests performed on the Explosafe 500.**

The Explosafe 500 was tested according to the United Nations Series 6(a) and © UN Tests and Criteria Manual, second edition. (Document ST/SG/AC.10/11/Rev.1).

The tests were performed by the Netherlands TNO laboratory for Scientific Research, Defence and Explosives Research Department.

### **Tests series 6(a) - Single detonation test**

For the single detonation test, the Explosafe 500 was loaded with a heavy steel (0.24" thick) cylinder with grooves.

This cylinder contained 340 grams (12 oz) of PETN plastic explosive, the equivalent to 500 grams (17.6 oz) of TNT.

This combination creates a serious bomb, with a powerful fragmentation effect.

The wires of the detonator, which was placed in the centre of the explosives, were guided through the opening of the pressure relief device.

The steel cylinder was centred in the Explosafe 500 by use of rubber rings; the container was subsequently placed in a bunker and electrical initiation was effected.

All blast and fragmentation effects were fully absorbed by the Explosafe 500, although minor deformation was visible on the outside of the container.

There was no danger to the surroundings or to the environment.

After detonation, it took one hour to release the pressure through the relief device.

In the immediate vicinity of the explosives, the pressure inside the Explosafe 500 was calculated at 200,000 bar (approx. 2,900,000 lbs per square inch), with an end pressure in the vessel of approximately 500 bar (7,250 lbs per square inch)

After detonation, the vessel could not be opened by hand, instead a light hammer was used. After removing the lid, it was apparent that the labyrinth inside the vessel was completely destroyed to debris.

Very small fragments of the steel cylinder were found loose in the vessel and in the inner walls of the container.

### **Tests series 6© - External fire (bonfire) test.**

The Explosafe 500 was loaded again, with 340 grams (12 oz) PETN plastic explosive, in a similar steel cylinder and was packed in a specially designed, UN approved 4A2, stainless steel box. The inside of the box was lined with 3" thick hard foam isolation material.

This packaging also passed the tests by the Netherlands Packaging Testing Institute TNO: the UN Packing Group II performance 4 ft. drop test and the 10 ft. stacking test.

The lid of the box was sealed by means of a steel lock.

- The stainless steel (4A2) box, containing the Explosafe 500 was placed on a grid.
- Air-dried pieces of wood were, according to the UN Tests and Criteria Manual procedures, piled under and around the packaging.
- Aluminum witness screens were placed in each of three quadrants, at a distance of 13 ft from the edge of the stack.
- The stack was drenched with 50 litres (13.2 gallons) of fuel (gasoline) and the pile was ignited electrically.
- The fire, with an estimated temperature of 1,200 C (2,192°F), lasted for an uninterrupted period of 30 minutes.
- At the end of the bonfire test, the outer packaging was red hot and was partly deformed.
- It took four (4) hours for the packaging to cool off, so it could be handled.

After opening of the stainless steel 4A2 box, containing the Explosafe 500, the following observations were made:

- The isolation material was partly burned and the paint of the Explosafe vessel was scorched.
- The cylinder, containing the explosive substance, could (4 hours after the fire) not be taken out by hand, due to the high temperature inside the vessel.
- After opening of the cylinder, it was found the explosive substance still was intact, as was the plastic bag, containing the substance.
- There was no evidence of any damage after this bonfire test.

### **Conclusion.**

Both Explosafe containment vessels successfully passed the UN series 6 tests.

The purposes of the vessels are multiple, viz.:

- a) Transportation of explosive substances or articles by all modes of transport, even by passenger aircraft;  
however, for transportation purposes either one of the Explosafes must be packed in the special UN 4A2 steel boxes;
- b) As a safety device:

to safely store detonators until connected to explosive substances, or to detonating cord (Explosafe 7.5), or  
for the safe removal and storage of explosives, to be handled by experts or bomb-squads (Explosafe 500).

A further advantage of the Explosafe 500 is that public areas, after discovery of bombs or other explosives, which are placed by terrorists, don't have to be evacuated for a long period.

### **Certification.**

The Dutch laboratory TNO, being the Competent Authority for classification of explosives in the Netherlands, concluded after completion of the tests that the following classifications are applicable for explosive substances and articles containing explosive substances  
(with exception of shaped charges):

**UN 0349      Articles, explosive, n.o.s., Class 1.4S**  
(DOT Class C), and

**UN 0481      Substances, explosive, n.o.s., Class 1.4S**  
(DOT Class C),

for respectively 7.5 grams (0.26 oz) TNT equivalence for the **Explosafe 7.5** and 500 grams (17.6 oz) TNT equivalence for the **Explosafe 500**, provided that the vessels are packed as tested.

Based on this TNO report, the Netherlands' Competent Authorities for transportation by Air- and Road have granted a 1.4S classification approval, according to the ICAO-TI (Air) and ADR (the European road transport regulations).

Acknowledgment and approval by US-DOT is pending.

For further information, a hard copy the official report of the TNO laboratory test, a video tape evidencing the tests, or how to order Explosafe containers, please contact:

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